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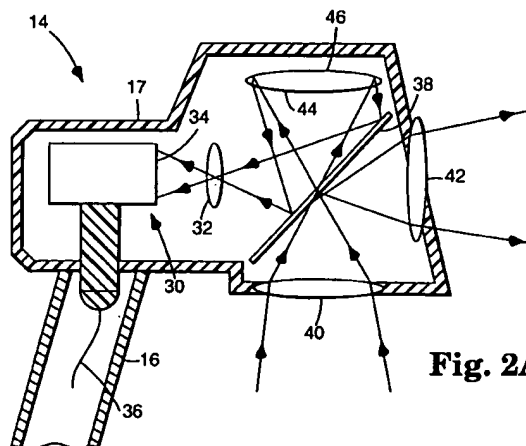
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DE FR GB IT(71) Applicant: **MINNESOTA MINING AND
MANUFACTURING COMPANY**
3M Center, P.O. Box 33427
St. Paul, Minnesota 55133-3427(US)(72) Inventor: **Holec, Henry V., c/o Minnesota
Mining and
Manufacturing Co. 2501 Hudson Road,
P.O.Box 33427**
St. Paul, Minnesota 55133-3427(US)
Inventor: **Madsen, David D., c/o Minnesota
Mining and
Manufacturing Co. 2501 Hudson Road**
P.O.Box 33427
St. Paul, Minnesota 55133-3427(US)(74) Representative: **Hilleringmann, Jochen,
Dipl.-Ing. et al
von Kreisler-Selting-Werner,
Deichmannhaus am Hauptbahnhof
W-5000 Köln 1. (DE)**(54) **Overhead projector with video output.**

(57) An overhead projector (OHP) which provides simultaneous video output of the image which is being projected on the projection screen. The OHP has a projector head (14) which contains conventional optical components (lenses 40,42) for projecting an image from the stage of the OHP to the projection screen, and further contains a partially silvered mirror (38) which passes a portion of the image to a video camera (30) located within the projector head (14). The camera (30) converts the visual information into an electronic signal in standard video format, which may then be transmitted to local or remote auxiliary displays.

**Fig. 2A****EP 0 550 038 A1**

Background of the Invention

1. Field of the Invention

The present invention generally relates to visual presentation systems, and more particularly to an overhead-type projector which projects an image on a screen and simultaneously captures the image electronically to allow display of the image on other video devices.

2. Description of the Prior Art

Overhead projectors (OHP's) are known in the art, and generally consist of a base having a stage area, a light source to illuminate the stage, and a projector head which houses mirrors and lenses designed to project any image placed on the stage area onto a display screen. OHP's may be either transmissive or reflective. In a transmissive OHP, the light source is under the stage area, i.e., opposite the side of the projector head. In a reflective OHP, the light source is above the stage area, typically near or even in the projector head, and the stage has a mirror-like surface to reflect the light back toward the head.

One important drawback in the use of OHP's lies in the fact that the image can only be projected onto a single projection screen; this consequently limits any presentation to a relatively small audience since it is difficult to view the screen from oblique angles, and those viewers farther from the screen will have great difficulty in observing any details in the projected image. Several solutions have been proposed to remedy this limitation, but each of these has additional disadvantages. For example, liquid crystal display (LCD) panels have recently been introduced for use with overhead projectors. These devices are controlled by computers (a personal computer or a "black box" containing a processor and memory storage devices). An exemplary LCD/OHP arrangement is shown in U.S. Patent No. 4,846,694. This type of system enhances the use of an OHP since the LCD controller may simultaneously direct the video output to other viewing devices, such as television monitors, which may be placed at several stations among the audience. The use of an LCD panel with an OHP, however, has plain disadvantages. Foremost among these is expense, since both the LCD panel and the computer controller are high-cost items. Also, an LCD panel can only project electronically stored images, which are typically prepared in advance of the presentation and stored in the controller's memory (hard disk or floppy diskette). This limitation prevents impromptu presentations as well as the ability of the presenter to modify or annotate prepared images. Although the

user could temporarily remove the LCD panel from the OHP and place a conventional transparency on the OHP stage, images from that transparency cannot be directed to the other viewing devices. Those skilled in the art will also appreciate that overhead projection of LCD images requires a brighter light source, leading to other problems such as heat management. LCD panels do, however, allow remote viewing of the images since they may be transmitted along telephone lines, etc.

Alternative designs satisfy the desire for remote viewing but, in doing so, completely eliminate the screen projection provided by OHP's. For example, the apparatus depicted in U.S. Patent No. 5,027,219 is specifically designed to capture an graphic image and transmit it to remote sites. This apparatus looks very similar to an OHP, but it cannot be used to locally and directly project an image onto a screen, and thus forfeits the many advantages of OHP's.

The foregoing device might be used in conjunction with the invention disclosed in U.S. Patent No. 4,609,779. That invention provides an OHP for projecting an image which is remotely transmitted, but does not address the issue of how the transmitting end may view the image with an overhead projector and simultaneously transmit the image to the remote reproduction device.

One elementary technique which preserves the use of the OHP but also provides for simultaneous video output involves the use of a conventional video camera which is simply aimed at the projection screen. This arrangement, however, introduces several new problems. The primary difficulty is that the resolution of the captured image is relatively poor due to the diffuse reflection of the image off of the projection screen; this problem can easily be exaggerated by lighting conditions. This technique clearly requires more set up time, and may further require that the user have substantial photographic skills. Also, problems may develop with the orientation of the camera with respect to the screen. Finally, since the camera must be placed in front of the screen, it will inevitably block the view of someone in the audience. It would, therefore, be desirable and advantageous to devise an apparatus which retains the advantages of an OHP, but which easily provides a simultaneous, high quality video output of the projected image to allow viewing at other local display devices, as well as at remote locations.

Summary of the Invention

The foregoing objective is achieved in an overhead projector having a image splitter located within the projector head, and further having a camera proximate the image splitter to receive the identical

image that is being projected onto a screen. The image splitter is preferably a partially silvered mirror which allows a very small percentage of light to pass through. The camera includes a CCD (charge-coupled device) area array imaging chip, and a multi-element lens which is aligned to receive that portion of the image which passes through the image splitter. The optical components may be optimized to eliminate a secondary image of the projector lamp, or a diffuser may be used with the lamp. The output of the camera is preferably converted into a standard video format which can then be transmitted to both local and remote display units. A projector head adapter may be provided to modify an existing overhead projector to allow simultaneous video output. The invention may further be designed for use with other accessories, such as a microphone, a conventional video camera, or a video cassette recorder.

Brief Description of the Drawings

The novel features and scope of the invention are set forth in the appended claims. The invention itself, however, will best be understood by reference to the accompanying drawings, wherein:

Figure 1 is a perspective view showing how a transmissive-type overhead projector constructed according to the present invention may provide a video signal to an auxiliary display unit;

Figures 2A-2C are side sectional views showing alternative arrangements of the optical components and camera in the projector head of the present invention;

Figure 3 is a side elevational view of the control panel used in the preferred embodiment of the present invention; and

Figure 4 is a perspective view illustrating the use of a projector head adaptor on a reflective-type overhead projector.

Description of the Preferred Embodiment

With reference now to the figures, and in particular with reference to Figure 1, there is depicted the overhead projector (OHP) 10 of the present invention. OHP 10 is generally comprised of base 12 and a head 14 supported by a post or support arm 16 having an adjustment knob 15 which raises or lowers head 14 or the optical components within head 14. OHP 10 further includes several conventional elements such as a light source 18 located in base 12, an on/off switch 20, a cable 22 for connection to an external power supply, and a stage 24 formed by a transparent sheet of glass which is positioned between light source 18 and head 14. The glass sheet forming stage 24 typically has a polymeric Fresnel condensing lens positioned im-

mediately beneath it. OHP 10 also has a video control/access panel 26 which includes a plurality of connectors for transmitting signals to an auxiliary display 28, as explained further below.

The present invention is directed to an OHP which has the ability to provide simultaneous video output of the identical image which is being projected through head 14 onto a projection surface or screen (not shown). In the preferred embodiments of the invention, this is achieved by locating a video camera within the housing 17 of projection head 14. Referring now to figures 2A-2C, those figures illustrate alternative arrangements for the location of a camera 30 in head 14. Camera 30 may be any camera capable of converting visual images into electrical signals, such as a vidicon tube, but the preferred camera is a solid state charge-coupled device (CCD) camera, due to its small size, low power consumption and longer service life. CCD camera 30 includes a multi-element lens schematically depicted at 32, positioned at the forward end 34 of camera 30, there being a silicon chip at end 34, formed with an area array of photosensitive elements. The output of the silicon chip comprises an ordered sequence of discrete electronic image signals that collectively define a single frame of image information. Camera 30 also includes a clock and conventional conversion circuitry to convert this data sequence into standard video format, viz., National Television Standard Code (NTSC). The converted data stream is passed by wires 36, which preferably are located within support arm 16, to control electronics which are located in base 12. The control electronics also provide the DC power needed for camera 30, this power being delivered through wires 36. In the prototype of OHP 10, the camera 30 used was purchased from Ampere Electronic Co. (a division of North American Philips Corp.) under model no. 56571.

In Figure 2A, an image splitter 38 in the form of a partially silvered mirror is used to withdraw a portion of the projected image and direct it to camera 30, and standard optical components are used to collect the image from stage 24 and project it towards the projection screen. A first projection or entry lens 40 located in an opening in housing 17 focuses light from stage 24 toward mirror 38; the majority of the light is reflected and passed through a second projection or exit lens 42 located in another opening in housing 17. Lenses 40 and 42 work together as a spaced doublet projection lens system to form the screen image. A portion of the light, however, passes through mirror 38 to reflecting lens 44, which has a reflective coating 46 on its backside. Lens 44 focuses the light and directs it back toward mirror 38, which further reflects it to camera lens 32. In this embodi-

ment, the lenses are preferably selected to form a secondary focus of the light inside camera lens 32, which provides a more efficient transfer of light through this smaller lens. One minor problem with this arrangement, however, is that lens 32 (which may has a very high f number ($f/12$) and a great depth-of-field) will also capture the primary focus of the light at mirror 38, creating a bright spot in the recorded image; this effect can be minimized by the use of a diffuser 48 (Figure 1) in front of light source 18. An appropriate diffuser is available from Spindler & Hoyer of Milford, Massachusetts. Placement of camera 30 at the back end of head 14 in this manner does, nevertheless, minimize obstruction of the projection screen since head 14 has a more streamline shape. Assuming light source 18 provides about 2500 screen lumens, and that head 14 is about 35 cm from stage 24, the following specifications are deemed preferably for the arrangement of Figure 2A: mirror 38--1% light transmission; entry lens 40--f number of about $f/7.4$ and focal length of about 640 mm; and exit lens 42--f number of about $f/6.7$ and focal length of about 600 mm.

In the arrangement of Figure 2B, the same projection lenses 40 and 42 are used, but reflecting lens 44 has been replaced by a conventional planar mirror 50. This arrangement is probably the least desirable since much of the light from stage 24 is not captured by camera lens 32, and lens 32 still sees the primary focus of the light, thus requiring diffuser 48 in order to minimize spots in the recorded image. Also, in each of the illustrated embodiments, alignment of the camera may affect the color quality of the recorded image, i.e., misalignment may result in a blue or yellow background rather than pure white, but this may be compensated for with the camera color controls.

In Figure 2C, the entry lens has been eliminated, and there is further no need for a reflecting lens or second mirror since camera 30 is placed directly behind image splitter 38 in line with an opening 52 in the bottom of head 14. This configuration is deemed most preferably since it allows the image of light source 18 to be formed within lens 32 as well as within lens 42. The image converges at these points due to the focusing effect of the fresnel lens in stage 24. Nevertheless, this arrangement had been found to create other small bright spots in the recorded image due to random pinhole imperfections in the coating on mirror 38. This problem was eliminated by opening up the iris of camera lens 32 (e.g., to $f/4$), which threw the pinhole images out of focus nearly to the point of disappearing completely. The camera focusing ring may then be used to form a sharp image of the transparency lying on stage 24. When so opening the camera iris, it is advisable to use an

appropriate filter 54, such as a neutral density filter obtainable from Melles Griot Co. of Irvine, California. When the camera iris is opened up to about $f/4$, filter 54 should provide about 13% transmission, and when the camera iris is opened up to about $f/2$, filter 54 should provide about 2% transmission. Filter 54 may be installed directly on camera lens 32. In the arrangement of Figure 2C, exit lens 42 is preferably a 280/315 mm varifocal lens provided by Y.K. Optical Co. of Yokohama, Japan, and mirror 38 has a first surface reflectance of about 94%. The fresnel lens in stage 24 should have a focal length of about 180 mm.

The video output of OHP 10 is further explained with reference to Figure 3, which depicts control/access panel 26. Panel 26 may be provided with a separate on/off switch 56 to enable the video output, in case OHP 10 is to be used without any auxiliary display 28. Panel 26 may optionally have a receptacle 58 for a generic power cord, and a small door 59 may provide access to a fuse. Six RCA-type connectors 60 - 70 are provided in a 2x3 array: one row for audio signals and the second row for video signals, and three columns corresponding to input, monitor, and output, respectively. For example, connector 60 corresponds to the audio input, and connector 66 corresponds to the video input; these two connectors allow OHP 10 to transmit signals other than a contemporaneous presentation to auxiliary display 28, e.g., prerecorded presentations which are played back on a video cassette recorder (VCR). A microphone jack 72 may be provided to add voice transmission to the visual presentation. Also, a jack 74 may be provided for an additional, external, camera (not shown). In this regard, the control electronics for OHP 10 may include a switching mechanism which causes the video output to change from camera 30 to the external camera when OHP 10 is turned off (or when a "black level" signal is detected from the output of camera 30). For example, the external camera may be aimed at the presenter; as long as OHP 10 is turned on, auxiliary display 28 will show the same image as that projected by OHP 10 onto the projection screen, but when OHP 10 is turned off, those viewing auxiliary display 28 will immediately see the presenter. Finally, a source switch 76 having "AUTO" and "MAN" settings may be provided to allow the operator to select between automatic and manual video sourcing modes. In other words, when switch 76 is set to "AUTO," the output to display 28 will switch as discussed above between camera 30 and the external camera, but when switch 76 is set to "MAN," the video source is manually controlled by, e.g., another button 77 on panel 26, or by remote control.

This novel combination of an overhead projector and video camera maintains all of the func-

tionalities and advantages of a conventional overhead projector but additionally provides the new function of video output. The immediate audience will have the standard benefits associated with overhead projection, while other audiences will receive a quality video image without the need for external cameras or camera operators. Furthermore, auxiliary display 28 may be any device capable of creating an image based on electronic data. It may comprise a television monitor, television projector, computer CRT, etc., or a plurality of any of the foregoing; these devices may be set up locally or at a distant locations, which could receive the electronic image data by phone lines, radio signals, or satellite communications. Also, auxiliary display 28 could be a recording device, such as a VCR. Alternatively, display 28 could constitute a liquid crystal display (LCD) panel which may be used in conjunction with a conventional overhead projector to project the same image onto a second projection screen, either local or remote.

Those skilled in the art will appreciate that the present invention may also be used on reflective-type overhead projectors, as shown in Figure 4. Figure 4 also illustrates how the present invention may be adapted to conventional overhead projectors. In Figure 4, the projection head of a conventional reflective OHP 80 has been removed and replaced with a head 82 which is essentially identical to one of the heads depicted in Figures 2A-2C, except that the light source 84 has now been located within head 82, directing light toward the reflective stage of OHP 80. The camera within head 82 is electronically connected to a control box 86 which includes the same control/access panel and control electronics previously described.

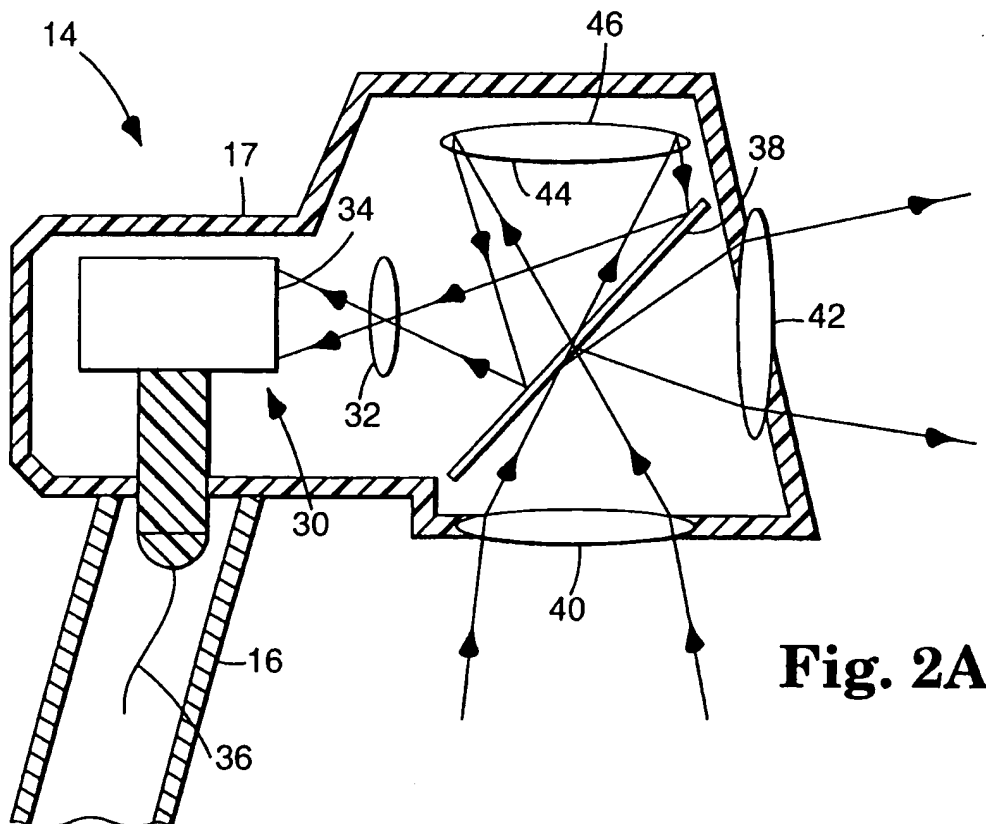
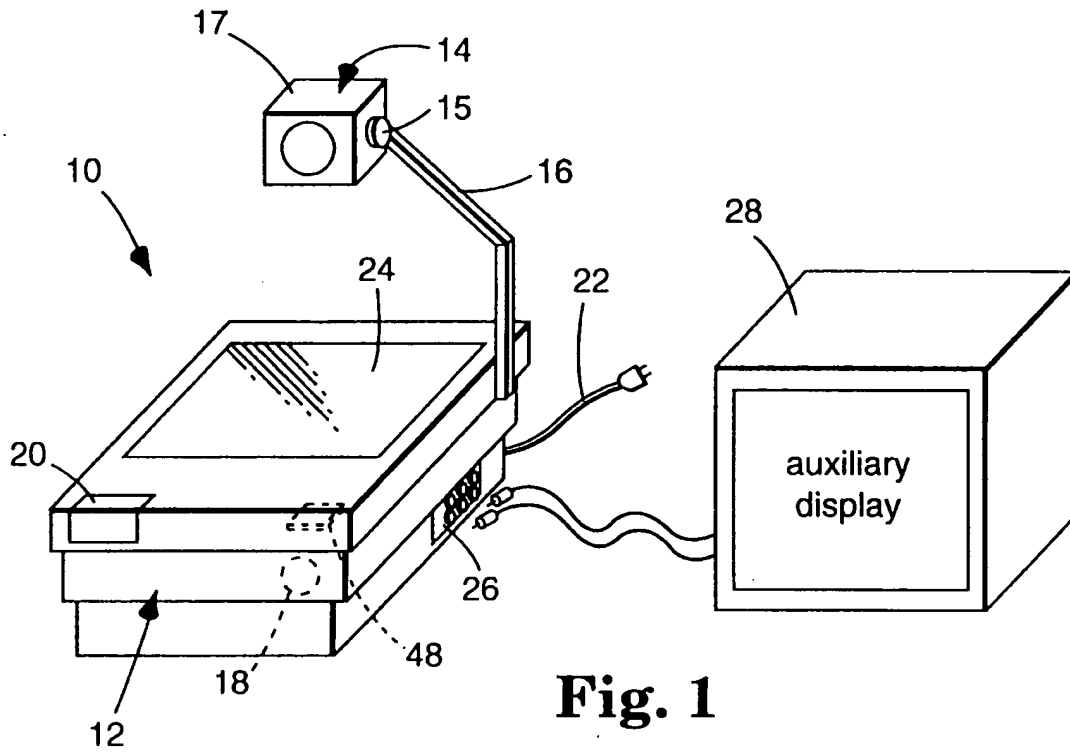
Although the invention has been described with reference to specific embodiments, this description is not meant to be construed in a limiting sense. Various modifications of the disclosed embodiment, as well as alternative embodiments of the invention, will become apparent to persons skilled in the art upon reference to the description of the invention. For example, alternative optical arrangements may be provided which allow placement of the video camera in base 12 rather than head 14, although this is considered less preferable. Also, the invention may be modified for opaque systems where light source 18 is extinguished, and an image on an opaque medium (such as paper) is placed on stage 24 and illuminated by other means. Additionally, camera 30 could be pivotally or otherwise mounted within head 14 in such a manner as to allow camera 30 to swing or move out of head 14 and be aimed at external objects. It is therefore contemplated that such modifications can be made without departing from the spirit or scope of the present invention as defined in the appended

claims.

Claims

- 5 1. A projection head comprising:
 - a housing (17),
 - optical means (40,42) located in said housing (17) for collecting an image and projecting the image,
 - 10 - image splitting means (38) located in said housing (17) for withdrawing a portion of the image collected by said optical means (40,42) and
 - 15 - camera means (30) located within said housing (17) for receiving the withdrawn portion of the image and converting it into electronic signals.
- 20 2. The projection head according to claim 1, characterized by neutral density filter means (54) interposed between said image splitting means (38) and said camera means (30).
- 25 3. The projection head according to claim 1 or 2, characterized by connector means (26,36) electronically connected to said camera means (30) for providing electronic video output to an auxiliary display (28).
- 30 4. The projection head according to any one of claims 1 to 3, characterized by means (46) for reflecting the withdrawn portion of the image towards said camera means (30).
- 35 5. A device for projecting an image onto a projection surface and for providing electronic signals corresponding to the projected image, comprising:
 - a base (12) having a stage area (24),
 - light means (18) for illuminating an image placed on said stage area (24),
 - a projection head (14) having a housing (17) attached to said base (12), proximate said stage area (24),
 - 45 - optical means (40,42) located in said projection head (14) for collecting light from the image and projecting the image onto the projection surface,
 - image splitting means (38) located in said projection head (14) for withdrawing a portion of the image collected by said optical means (40,42) and
 - 50 - camera means (30) located within said housing (17) for receiving the withdrawn portion of the image and converting it into electronic signals.
 - 55

6. The device according to claim 5, characterized by connector means (26,36) electronically connected to said camera means (30) for providing electronic video output to an auxiliary display (28). 5
7. The device according to claim 5 or 6, characterized in that said camera means (30) comprises a solid state charge-coupled device which provides an electronic data sequence corresponding to image information, and a camera lens (32) mounted adjacent said charge-coupled device. 10
8. The device according to claim 6 or 7, characterized by 15
- switch means (20) for turning said light means (18) on or off,
 - an external camera and
 - control means (58) electrically connected to said external camera, said switch means (20), and said connector means (26,36) whereby, when said light means (18) is turned on, said electronic video output derives from said camera means (30) and, when said light means (18) is turned off, said electronic video output derives from said external camera. 20 25
9. The device according to claim 7 or 8, characterized in that the f number of said camera lens (32) is sufficiently low to render an image of any pinhole imperfections in said partially silvered mirror (38) out of focus at the surface of said charge-coupled device. 30 35
10. A presentation system providing simultaneous video output of an image which is being projected onto a projection surface, comprising:
- a base (12) having a stage (24) formed of a sheet of transparent material, said sheet further having a fresnel lens thereon, 40
 - a light source (18) located in said base (12), 45
 - a projection head (14) attached to said base (12), proximate said stage (24) and opposite said light source (18), said projection head (14) having an entry opening and an exit opening, and having a projection lens (42) in said exit opening, 50
 - a partially silvered mirror (38) located in said projection head (14), having a generally flat surface which is oriented with respect to said entry and exit openings so as to reflect light entering through said entry opening toward said exit opening, 55
- a video camera (30) located within said projection head (14) and positioned to receive light images passing through said partially silvered mirror (38), said video camera (30) including a charge-coupled device, a lens (32) adjacent said charge-coupled device, and circuitry means for converting electronic signals from said charge-coupled device into National Television Standard Code format,
 - an auxiliary display (28) and
 - means (26,36) for transmitting output from said video camera (30) to said auxiliary display (28).
11. A presentation system providing simultaneous video output of an image which is being projected onto a projection surface, comprising:
- a base (12) having a stage (24) formed of a sheet of reflective material, said sheet further having a fresnel lens thereon,
 - a projection head (14) attached to said base (12) proximate said stage (24), said projection head (14) having an entry opening and an exit opening, and having a projection lens (42) in said exit opening,
 - a light source (18) located in said projection head (14) directing light toward said stage (24),
 - a partially silvered mirror (28) located in said projection head (14), having a generally flat surface which is oriented with respect to said entry and exit openings so as to reflect light entering through said entry opening toward said exit opening,
 - a video camera (30) located within said projection head (14) and positioned to receive light images passing through said partially silvered mirror (38), said video camera (30) including a charge-coupled device, a lens (32) adjacent said charge-coupled device, and circuitry means for converting electronic signals from said charge-coupled device into National Television Standard Code format,
 - an auxiliary display (28) and
 - means (26,36) for transmitting output from said video camera (30) to said auxiliary display (28).



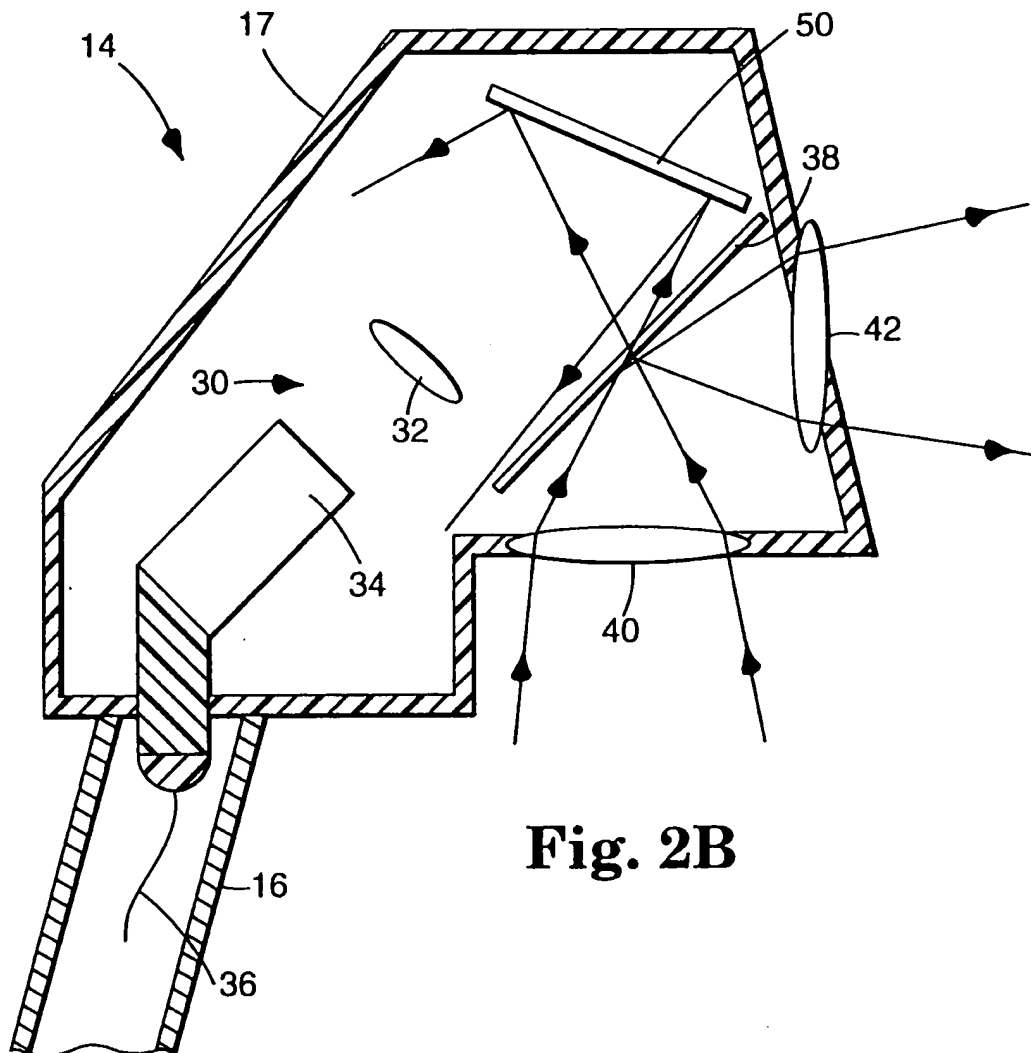


Fig. 2B

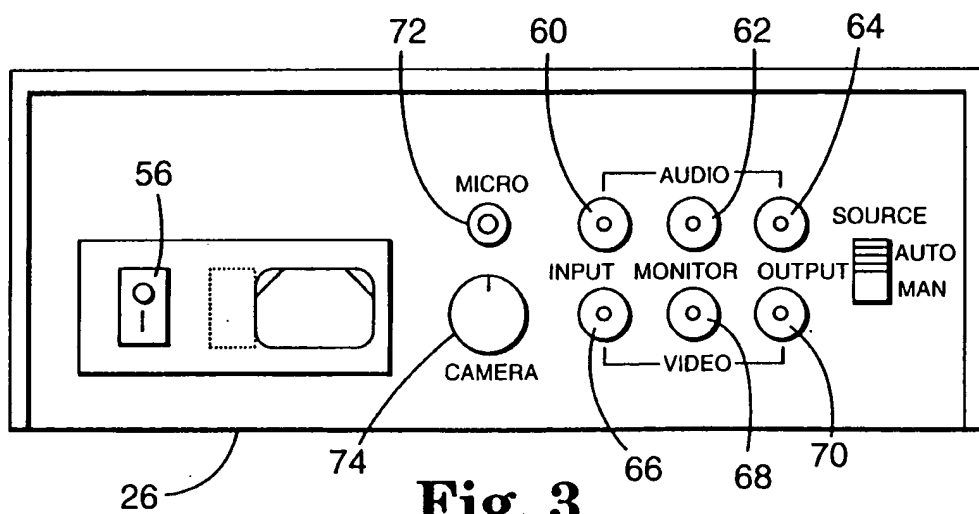


Fig. 3

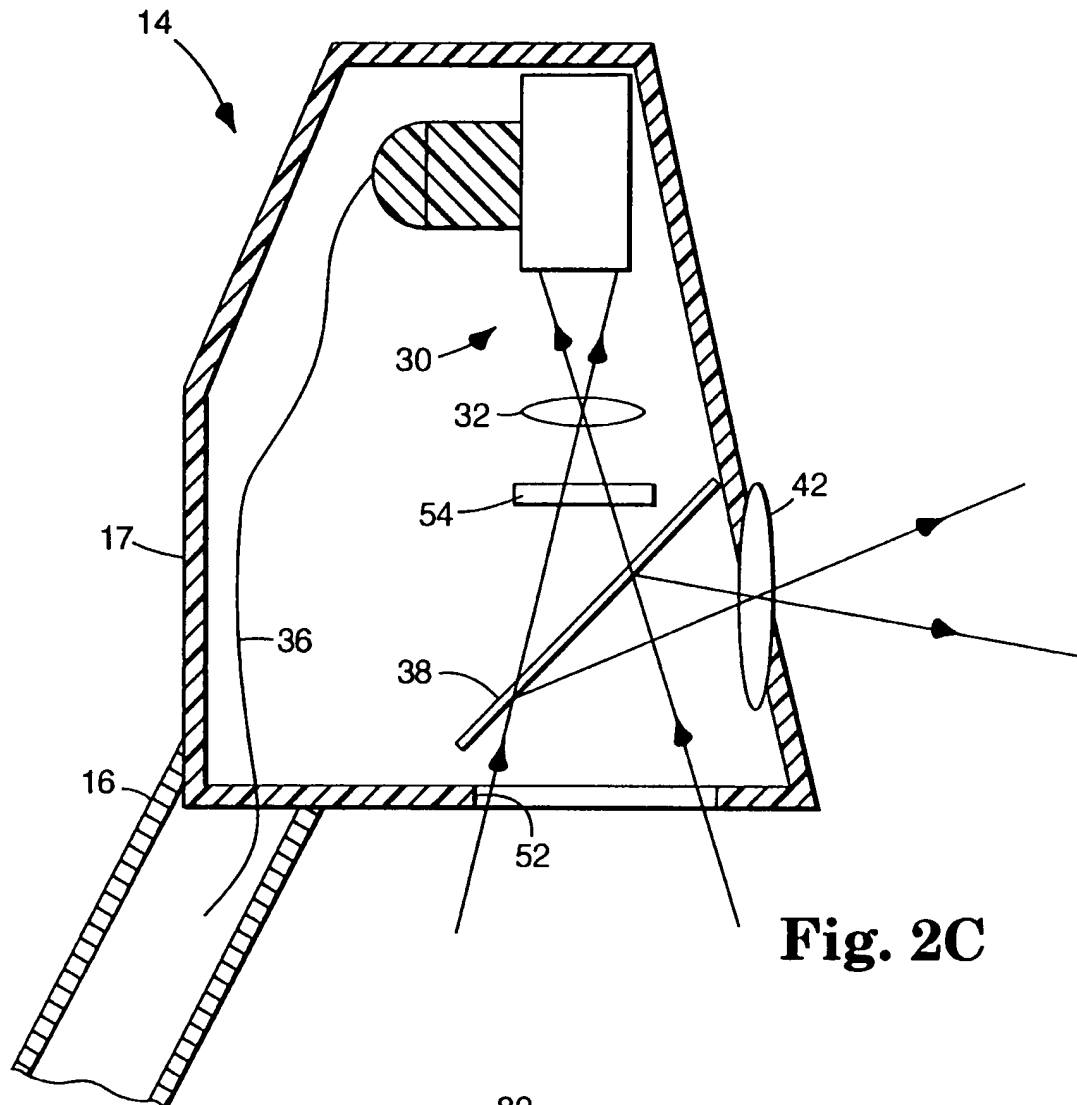


Fig. 2C

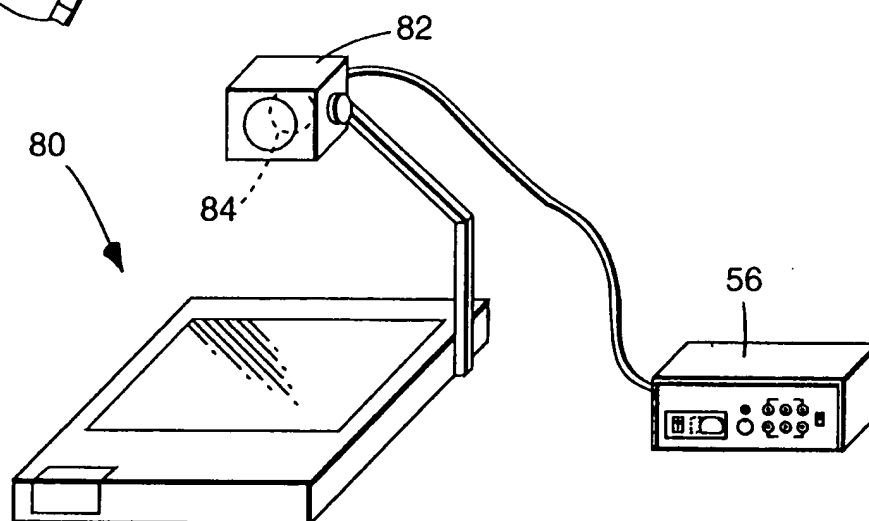


Fig. 4



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EUROPEAN SEARCH REPORT

Application Number

EP 92 12 2017

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	PATENT ABSTRACTS OF JAPAN vol. 14, no. 558 (P-1141)12 December 1990 & JP-A-02 238 485 (TOSHIBA) 20 September 1990	1,5	G03B21/132 H04N1/00
A	* abstract; figure * ---	7,10,11	
A	PATENT ABSTRACTS OF JAPAN vol. 10, no. 184 (E-415)27 June 1986 & JP-A-61 030 167 (OKI ELECTRIC) 12 February 1986 * abstract; figure * ---	1,5,7, 10,11	
D,A	EP-A-0 362 737 (JOSEF WOLF AUDIO-VISUALS) * the whole document * -----	1,3-7, 10,11	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			G03B H04N
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 30 MARCH 1993	Examiner S.M WARD
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application I : document cited for other reasons & : member of the same patent family, corresponding document			

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